

Blood Volume Unloading Reduces Cerebral Blood Flow

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Abstract

Introduction: Cerebral autoregulation (CA) has been understood for over 50 years to maintain constant cerebral blood flow (CBF) over a wide range of arterial blood pressures (60-150 mmHg), and blood volumes. The original work, which published this relationship, however, was derived from a limited number of studies focused primarily on clinical populations. Since that time, it has been applied to healthy individuals and is a mainstay of almost all physiology textbooks. Recent evidence, however, has suggested that CBF in healthy individuals is not independent of alterations in blood pressure and volume, indicating a possible absence of cerebral autoregulation. Lower body negative pressure (LBNP) and lower body positive pressure (LBPP) are two techniques that involve the non-invasive manipulation of blood volume through the application of either positive or negative pressure on the lower limbs. Application of LBNP works to reduce upper body blood volume, while the opposite effect occurs with LBPP. In this study, through the use of both LBNP and LBPP we aimed to investigate the effects of altered blood volume on CBF in healthy individuals.

Methods: Systolic and diastolic blood flow velocity through the middle cerebral artery (Transcranial Doppler, Viasys, San Diego, CA) was measured at baseline and during four stages of LBNP (-20, -40, -60, and -80 mmHg), and three stages of LBPP (+20, +40, +60 mmHg) in seven participants. In addition, brachial blood pressure was measured at each stage using an automated cuff. The effects of the LBNP and LBPP on all measures were examined using repeated measures ANOVA. Upon review of the results from LBPP evidence of a possible threshold became apparent. Stages 0 and +20, and +40 and +60 mmHg were therefore pooled and analyzed using a paired t-test.

Results: LBNP induced a reduction in cerebral systolic ($p<0.001$), cerebral diastolic ($p=0.038$), and cerebral mean arterial ($p=0.002$) blood flow velocity. LBPP induced increases in brachial systolic ($p<0.001$), brachial diastolic ($p=0.005$), and brachial mean arterial ($p<0.001$) blood pressures. An LBPP-induced increase in cerebral diastolic blood flow velocity was found between the pooled stages of 0 and +20, and +40 and +60 mmHg ($p=0.008$).

Conclusion: This study supports recent evidence demonstrating the absence of a cerebral autoregulatory response in healthy individuals, as alterations in systemic blood volume can clearly result in similar changes in CBF.